STATUS REPORT ON THE SEARCH FOR SOURCE CRATERS OF ALH8001. N. G. Barlow, Dept. of Physics, University of Central Florida, Orlando, FL 32816 ngb@physics.ucf.edu.

ABSTRACT

Two candidate source craters for the 4.5 Gyr old martian meteorite ALH84001 were reported last year. The search criteria were (1) fresh crater morphology, (2) crater superposed on ancient terrain, and 3) sizes ≥100-km-diameter for circular craters and ≥10-km-diameter if elliptical. Several suggestions following the LPSC presentation have been incorporated into the on-going search. These include (1) checking for fresh craters on the ejecta blankets of large craters regardless of terrain, (2) checking fresh craters on younger terrain when crater is close to a boundary with ancient terrain, and (3) inclusion of circular craters down to about 20-km-diameter. This report discusses the results of the analysis for craters ≥20-km-diameter located on ejecta blankets and near highlands boundaries.

BACKGROUND

ALH84001 is an igneous orthopyroxenite which has been determined to be from Mars [1]. It has a crystallization age of 4.5 Gyr, making it the oldest of the known martian meteorites [2]. A pre-ejection shock event has been determined from Ar-Ar analysis to have occurred about 4 Gyr ago [3] and the cosmic ray exposure age indicates it was ejected from Mars about 16 Myr [4]. Cosmic-ray produced nuclear tracks suggest the object was approximately 20-cm in diameter before entering the Earth's atmosphere 13,000 years ago [5]. The large concentration of carbonates suggests interaction with water, although most of the meteorite shows little evidence of subsequent aqueous alteration [6]. Debate is ongoing as to the age of the carbonates, their formation temperature, and whether chemical evidence and structures within the carbonates are biogenic in nature.

Last year I reported on the search for possible source craters of ALH84001 [7]. The search was constrained by information from the meteorite and our current understanding of how material can be ejected off Mars. The 4.5 Gyr crystallization age of the meteorite indicated the rock came from an ancient terrain on Mars. The search was thus limited only to terrain units identified as forming around 4.5 Gyr based on stratigraphic analysis [8]. The units searched are those denoted as Npl_1, Npld, Nple, Nplr, Nplh, Nf, and Nb on the USGS stratigraphic maps of Mars. The 16 Myr ejection age indicated that the crater responsible for the meteorite should still appear very fresh since the martian erosional environment is believed to have been at its current low level throughout this time period. This led to the constraint that the crater should be very pristine, with sharp rim, fresh ejecta blanket, and few to no superposed primary craters. Last year's results also utilized the crater size and shape constraints previously used in searches for source craters of the other SNC meteorites. These constraints included circular craters ≥100-km-diameter and elliptical craters ≥10-km-diameter. The initial search using these criteria produced 23 possible source craters (13 ≥100-km-diameter, 10 elliptical). Photogeologic analysis of these 23 craters revealed that many displayed evidence of being older than the 16 Myr ejection age (eroded ejecta, breached crater rim, superposed primary craters, etc.). Two craters were identified as being the best candidates: a 11.3 x 9.0 km crater located east of Hesperia Planum at 11.7°S 243.3°W and 22.9 x 14.6 km crater located south of the Schiaparelli impact basin at 14.0°S 343.5°W.

THIS STUDY

Following the discussions from last year's LPSC presentation, we have returned to the data in the *Catalog of Large Martian Impact Craters* to incorporate new search criteria. The first change has been in regard to the size and shape of the parent crater. Calculations by H. J. Melosh [9] indicate that for a 20-cm-diameter to be ejected from Mars, the source crater has to be at least 20 km in diameter, even if the impact creating the crater is near-vertical. We have therefore extended the study to include circular craters between 20 and 100 km in diameter. Using this size limit, we have addressed the other two suggested changes to the search criteria: (1) looking at fresh craters superposed on the ejecta blankets of large craters, including those on young terrain since the initial impact may have excavated buried ancient material, and (2) looking at fresh craters located on young terrain but within 100-km of a highlands boundary since material from the highlands may have been deposited in these areas by impact, mass wasting, or other geologic processes. We also have taken a closer look at fresh craters located within outflow channels where flowing water may have deposited material from ancient terrain further downstream.

RESULTS

With the new search criteria input into the *Catalog of Large Martian Impact Craters*, the initial results revealed 4 possible craters located on ejecta blankets, 59 near highlands boundaries, and 5 within channels. As before, we utilized Viking Orbiter imagery (resolutions ranged from 40 to about 200 m/pixel resolution) to conduct a photogeologic analysis of the preservational state of each crater and were able to eliminate most on the basis of features suggesting a crater formation age older than 16 Myr. Of the initial 68 craters, only 6 remain as possible candidate craters for ALH84001. Two of the remaining six are found within outflow channels while the other four are found near highlands boundaries. The craters are

21.7 km	18.71°N	56.50°W
26.0 km	6.85°N	36.22°W
54.2 km	7.51°N	33.01°W
20.7 km	8.07°N	260.23°W
22.8 km	32.45°S	67.00°W
22.4 km	41.49°S	182.06°W

The 21.7 km and 54.2 km craters are located in outflow channels which abut Nplh and Npl_1 terrain, respectively. The other four craters are found near boundaries with Nplh or Npl_1 terrain.

We are currently running the analysis for circular craters ≥20-km-diameter on ancient terrain. The initial results indicate approximately 600 craters meet the criteria. The craters remaining after the photogeologic analysis will be reported at the conference.

DISCUSSION

The inclusion of circular craters ≥20-km-diameter and those outside of ancient terrain but which may have sampled exposures of such material have increased the number of potential source craters for ALH84001 substantially. However, photogeologic analysis continues to be able to reject many of these craters as being too old. Mineralogical data expected from Mars Global Surveyor compared with the mineralogy of the meteorite may help to further constrain which possible craters are the strongest candidates for the source of ALH84001.

References: [1] Mittlefeldt D. W. (1994), *Meteoritics*, **29**, 214-221. [2] Jagoutz E. et al. (1994), *Meteoritics*, **29**, 478-479. [3] Ash R. D. et al. (1996), *Nature*, **380**, 57-59. [4] Swindle T. D. et al. (1995), *Geochem. Cosmochem. Acta*, **59**, 793-801. [5] Goswami J. N. et al (1997), *Meteoritics*, **32**, 91-96. [6] Treiman A. H. (1996), *LPI Tech. Rpt. 96-01, Part 1*, 45-46. [7] Barlow N. G. (1997), *LPSC XXVIII*, 65-66. [8] Tanaka K. L. et al. (1992), in *Mars*, Univ. Az Press, 345-382. [9] Melosh H. J. (1988), *Nature*, **332**, 687-688.